

METAL GIRDER



BRIDGES

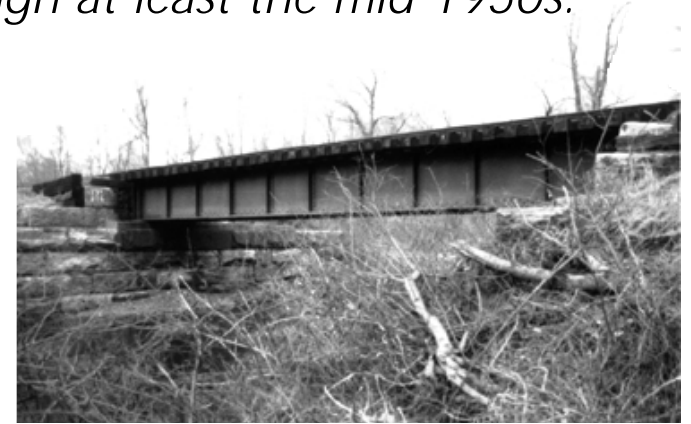
In Delaware, as in most other states, steel girder bridges were the most frequently built types of highway bridges from the late 1910s through at least the mid 1950s.



This chapter includes multi girder bridges that are longitudinal beams with no transverse floorbeams, and girder and floorbeam bridges (i.e. deck girder and thru girder, see page 118). The engineering principle underlying all types of girder bridges is the same; the bending strength of the material resists the load. Most often, the multi girder bridges are composed of rolled wide flange beams. The built-up girder and floorbeam bridges are generally used for the longer spans.

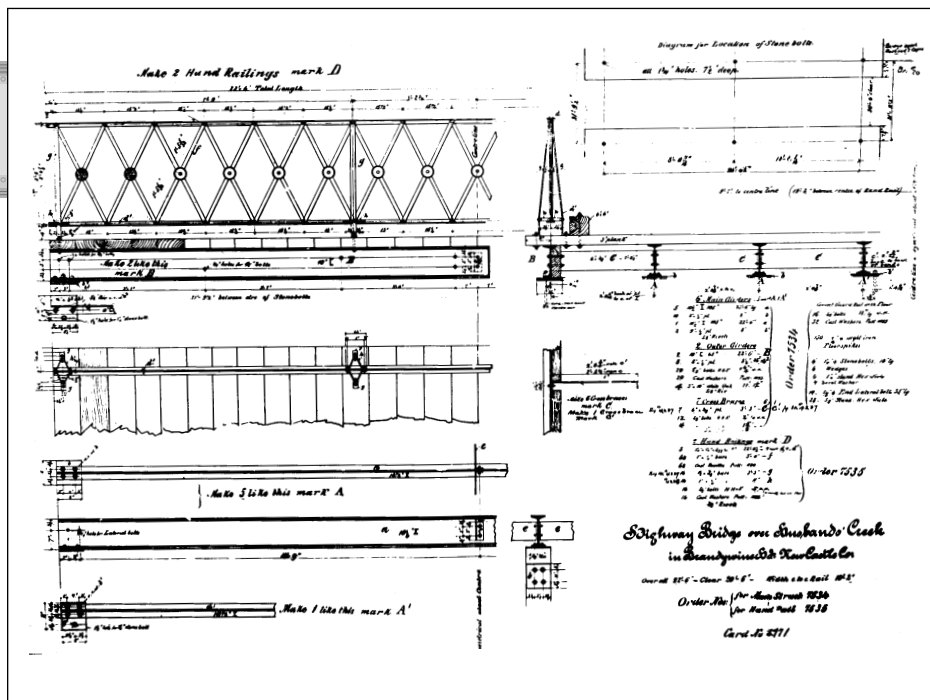
An important advance in girder technology occurred with the transition from wood to metal girders in the mid-19th century. America's antebellum bridge engineers un-

A steel multi girder bridge (non-extant) with lattice railings and stone abutments and wingwalls on Duncan Road, New Castle County, ca. 1920.

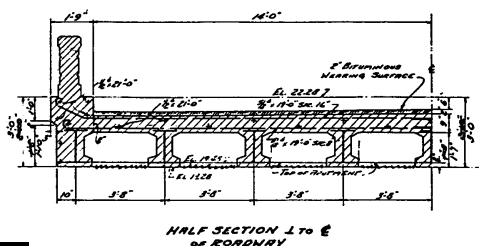
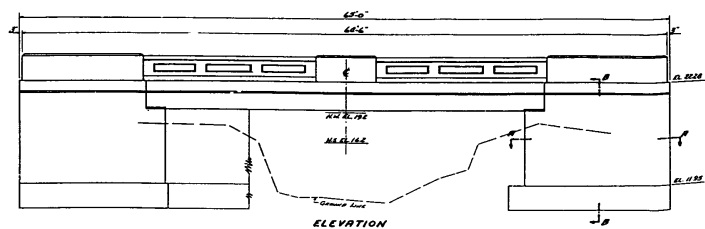


Conrail Bridge Number 44.75, built in 1903, carries the Delaware Railroad over St. Jacobs Creek near Dover. The metal girder bridge technology was fully developed by America's railroads by the last quarter of the 19th century. The girder bridges were built prolifically across the United States throughout the first half of the 20th century.

derstood the superior bending strength of metal but the initial development of the technology, and its widespread application, relied upon later improvements in the manufacture of rolled-iron structural shapes, such



ABOVE: Plans for a simple steel multi girder bridge composed of rolled I-beams supporting a wood plank deck enclosed by lattice railings. Rockland Road over Husbands Run, near Rockland, New Castle County, ca. 1900, replaced in 1932 by State Bridge NC-20.



LEFT: Plans for the Road 46 over Deep Creek bridge (State Bridge S-239) at Old Furnace, Sussex County. The 1932 drawings illustrate the state highway department bridge division's standard design for encased steel multi girder bridges. Similar bridges were built in numbers from the 1920s to the 1950s.

as angles, channels, plates, and I-beams.

Wrought-iron girder bridges were introduced by the railroads as early as 1847. In most in-

stances, the railroads used built-up beams, composed of rivet-connected plates for the web and angles for the flanges, to make a beam of sufficient depth to span greater distances than possible with then available rolled beams. (Depth of a beam is related to span length, with the greater the desired length, the greater the depth.) Built-up girder with transverse floorbeams bridges proved to be efficient and economical for railroad-carrying spans, and they were the only se-

rious competitors to metal trusses for railroad use in the late-19th century. Bridge engineers especially appreciated the ease of installation. Since the built-up girders were almost completely assembled in fabricating shops, conveniently located on rail lines, they could be loaded easily onto flatbed cars. Once at the site, cranes quickly hoisted them into position with minimum traffic interruption. The ability to transport the girders was often a factor limiting their length, and in general, built-up girder highway bridges were not built in great numbers prior to 1900 because of the difficulty of transporting the beams overland by wagons or sleds. Most extant 19th century girder bridges and many 20th century ones are associated with railroads.

By the 1890s, improvements in the open-hearth steel making process resulted in larger quantities of structural steel at lower prices. A major technological breakthrough occurred in 1908 when the Bethlehem Steel Company began producing wide-flange rolled steel beams on the Grey Mill, named

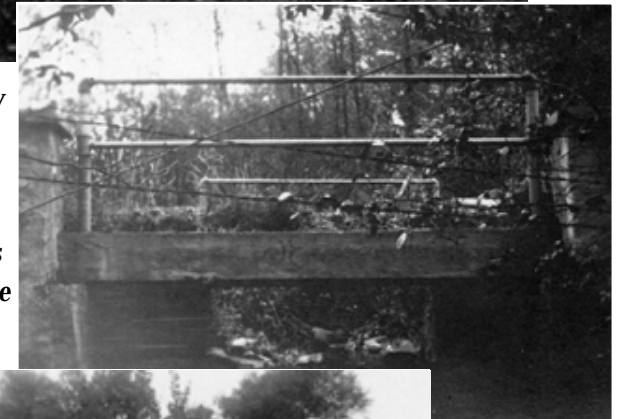
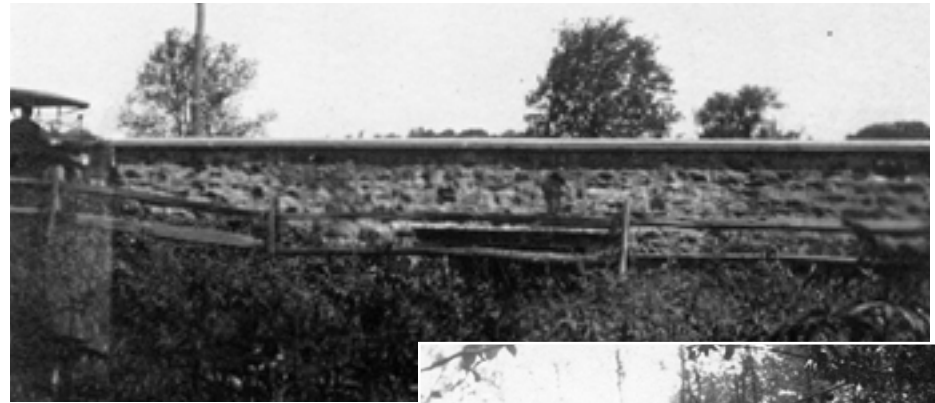
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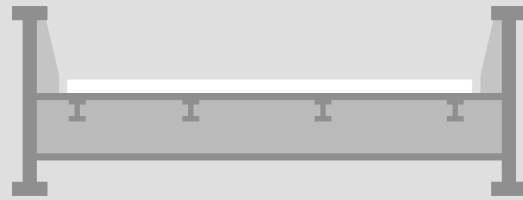
after its inventor Henry Grey. The mill rolled beams at greater speeds and depths and at an approximately 10 percent savings in material with no reduction in strength. Although the company first met difficulties marketing the new 26", 28", and 30" deep beams, Bethlehem had overcome the problems by the early 1910s. In his 1916 edition of *Bridge Engineering*, J. A. L. Waddell touted the superiority of the improved steel I-beams, calling them "a great boon to bridge designers and builders" because of their simplicity, compactness and lower price.

As a class, rolled steel multi girder bridges proved ideally suited for the highway building campaigns of the 20th century. They came to the fore before World War I, and by the mid 1920s, rolled section multi girder bridges were ubiquitous. The advantages of the technology were particularly attractive to state and county bridge engineers for spans up to 60' in length. They could be easily erected with readily available beam sections and were cheaper than pony truss bridges. Rubber-tired trucks and

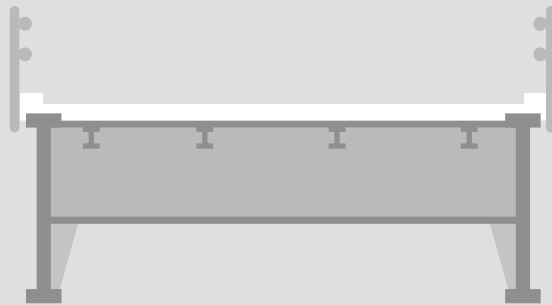
Steel multi girder bridges were a simple, low-price solution for the bridge building needs of Delaware's county governments during the early 20th century. New Castle County bridge photos of the 1920s and 1930s illustrate at least 40 such bridges. No such archives exist for the lower counties, but written records indicate that Kent and Sussex county governments had adopted the bridge type by the end of the first decade of the 20th century. Typical non-extant examples from the New Castle County bridge photo archives include a concrete-encased steel multi girder bridge with stone parapets on the Lancaster Pike (Above), a concrete encased steel multi girder span with metal pipe railings on Silverside Road (Center) and a concrete-encased steel multi girder bridge with concrete parapets near the Maryland line (Below).



Metal Girder Bridges



*Thru Girder
Cross Section*



*Deck Girder
Cross Section*



*Multi Girder
Cross Section*

improved heavy construction equipment eased the problems of transporting girders and on-site erection. With primarily accessible flat surfaces, girder bridges were easier to clean and paint than trusses, and a concrete deck over the beams added protection from exposure.

The multi girder, thru girder, and deck girder are the three most common girder bridge types. The *multi girder* type consists of a series of parallel, longitudinal steel beams supporting a deck. Concrete or steel diaphragms are often used between the beams to stiffen multi girder bridges. The deck and thru girder bridge types are distinguished from the multi girder by transverse floorbeams between the longitudinal girders, which are usually built up rather than rolled. The *thru girder* is where the floorbeams are placed in line with the bottom flanges of the girders with the roadway passing between the paired girders. The *deck girder* is where the floorbeams are placed near the top flanges of the girders and the roadway located at the top of the girders. Deck girders are often associated with locations where vertical clearances are

not critical.

In Delaware, as in most other states, steel multi girder bridges were the most frequently built type of highway bridges with span lengths of over 20' from the late 1910s through at least the mid 1950s. They continue to be built today. Delaware's state highway department and county engineers prepared standard specifications for multi girder bridges, facilitating quick and economical design and construction. The Kent County engineer, for instance, issued "General Specifications for Highway Bridges" (ca. 1910) to provide written directions to contractors for simple multi girder bridges on rubble masonry abutments. Such standard specifications, often taken from correspondence-school textbooks or technical pamphlets prepared by the federal government or professional engineering societies, were not a milestone in the development of bridge technology, but rather an economical and expedient engineering solution that found broad application across the nation in the early 20th century. Another advantage of multi girder bridges that was particularly important in the era of rapidly in-

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creasing traffic volume and weight demands was the ability readily to widen the bridge or salvage the beams for reuse at another location.

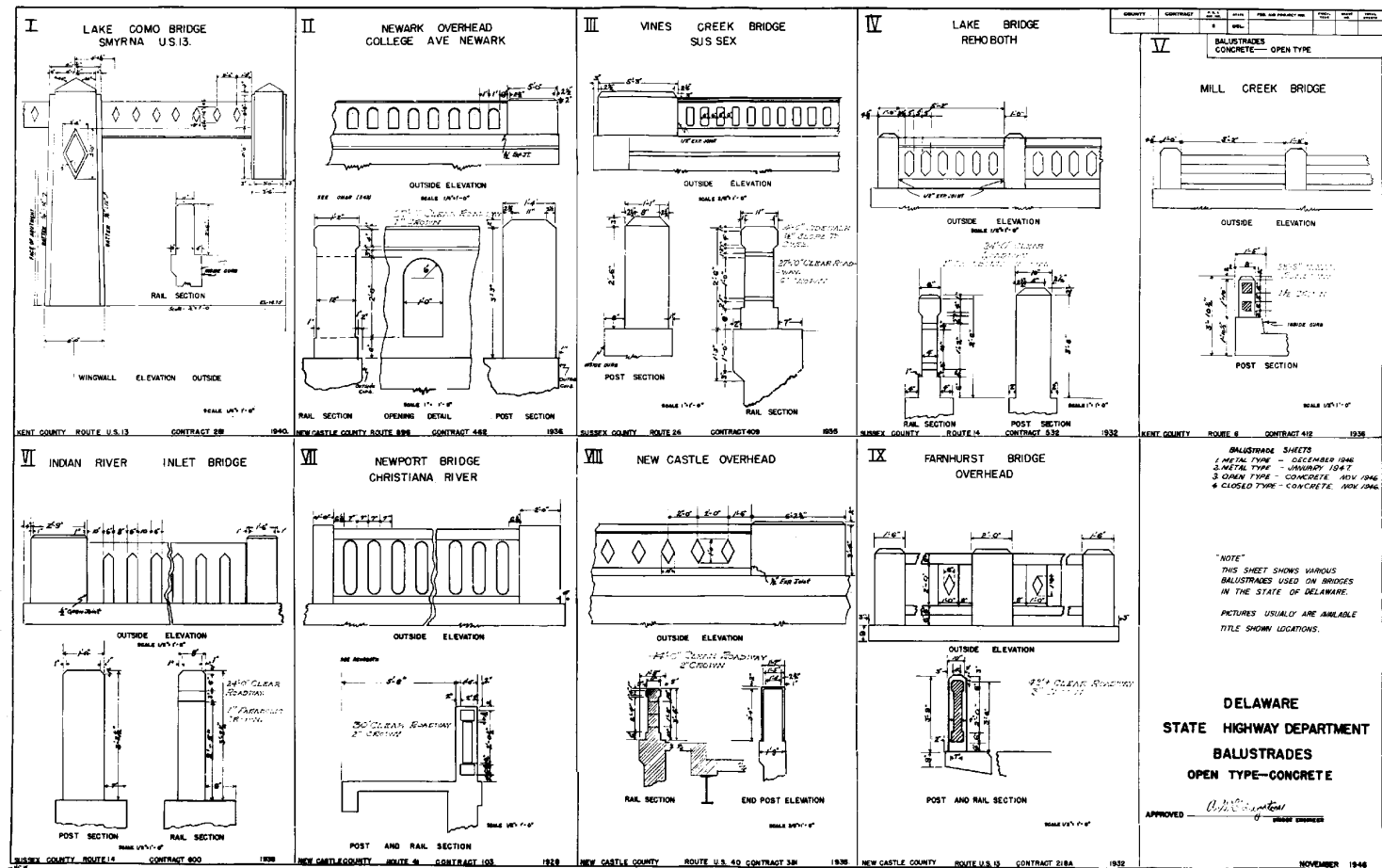
A common detail of steel multi girder bridges is the concrete encasement of the beams. The technique was introduced in the 1890s to protect beams from corrosion and eliminate the need for periodic painting. Although it added dead load to the bridge, encasement had long-term maintenance cost benefits and was used frequently as a technique by highway departments and railroad companies through the mid-20th century.

Economy of design and ease of construction were the most significant factors in the bridge type's widespread and long-lived use. Historically, multi girder bridges frequently were finished with paneled concrete parapets, concrete balustrades, or decorative metal railings designed to be both safe and attrac-

tive. In general, architectural treatments, when applied, reflected period tastes and styles. After 1945, bridge builders increasingly turned to stock railings, such as W-

beam and wire-rope guide railings.

Under the tenure of State Bridge Engineer Arthur G. Livingston (1918-1948), multi girder bridges on Delaware state highways re-



A 1946 plan sheet illustrates nine variations of concrete balustrades used by the Delaware State Highway Department during the 1930s and 1940s.

The Locations of Delaware's Historic Metal Girder Bridges



1. Still Road over Choptank River
State Bridge K-211A
South of Marydel, Kent County

2. Frederica Road over Murderkill River
State Bridge K-8F
Frederica, Kent County

3. Faulkland Road over Hyde Run
State Bridge NC-182
Northwest of Prices Corner,
New Castle County

4. North Market Street over Brandywine Creek
State Bridge NC-575
Wilmington, New Castle County

5. Old Capital Trail over Red Clay Creek
State Bridge NC-155
Marshallton, New Castle County

6. Road 46 over Deep Creek
State Bridge S-239
Old Furnace, Sussex County

7. Rockland Road over Wilson Run
State Bridge NC-68
Rockland, New Castle County

8. Rockland Road over Brandywine Creek
State Bridge NC-2
Rockland, New Castle County

9. Washington Street over Mispillion River
State Bridge K-501
Milford, Kent County

10. Silver Lake Road over Silver Lake Spillway
State Bridge NC-407
Southeast of Middletown,
New Castle County

11. Carr Road over Shellpot Creek
State Bridge NC-543
Bellevue State Park, New Castle County

12. State Route 7 over Christina River
State Bridge NC-257
Christiana, New Castle County

13. Snuff Mill Road over Red Clay Creek Tributary
State Bridge NC-88
West of Centreville, New Castle County

14. State Route 82 over Red Clay Creek
State Bridge NC-119
Ashland, New Castle County

15. State Route 20 Eastbound over Conrail and Cedar Street
State Bridge S-257E
Seaford, Sussex County

16. State Route 141 over Brandywine Creek and Road 260
State Bridge NC-587
East of Greenville, New Castle County

ceived a variety of individualistic aesthetic railings, in both metal and concrete, some with diamond-shape cutouts or panels (for the Diamond State) or Art Moderne-style architectural detailing. In northern New Castle County, Livingston faced steel girder bridges as well as reinforced concrete bridges with native stone in a desire to blend the bridges with the natural landscape. The practice of stone facing, begun by Livingston in the 1930s, continues today.

Over 120 steel girder bridges from 1901 to 1956 have been identified by the Delaware historic bridge inventory. Pre-World War I bridges are with few exceptions standard thru girder bridges, many built as part of grade-crossing elimination programs by the Pennsylvania and B&O railroads in Wilmington. The railroad-built girder bridges represent the continuance of the built-up girder technology that was well established during the second half of the 19th century.

The majority of surviving girder highway bridges date from after World War I and were built by the state, counties, or municipalities as part of ongoing road improvement campaigns. In general, highway bridge engineers handled girder bridge design in a formulaic manner and very few examples are noteworthy for innovative features. Early standard examples and those that first incorporated later refinements of design, such as achieving economy of material by making the beams continuous over the piers, and aesthetic treatments, such as

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stone facing or Art Moderne-style architectural detailing, best represent the significance of the bridge type in the Delaware context. The Delaware historic bridge inventory has identified 16 girder bridges, dated from ca. 1909 to 1952, that stand out in the larger population based on their age, technological details, aesthetic treatments, or geographic distribution.

Still Road (Road 211) over Choptank River (Carters Bridge)

State Bridge K-211A

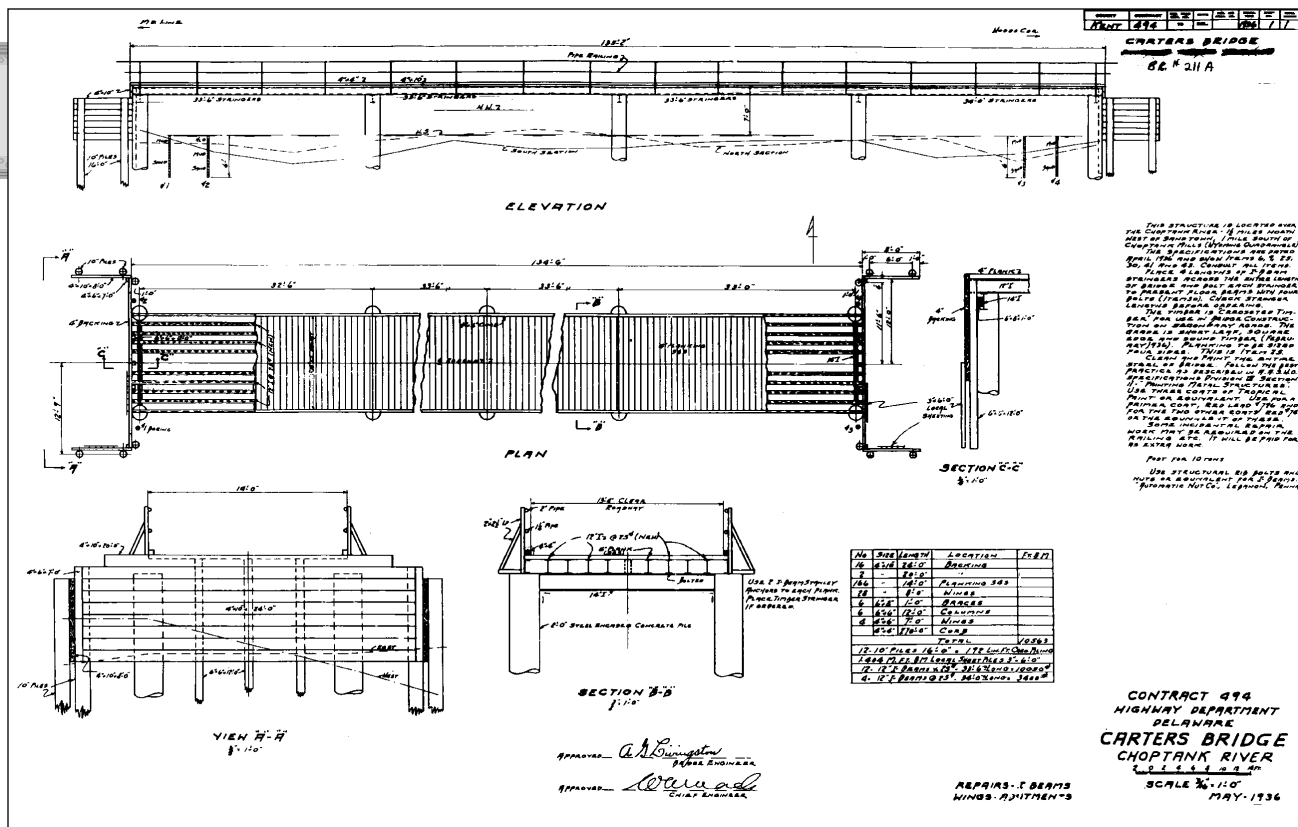
South of Maryland, Kent County

*Designer/Builder: Canton Bridge Company
ca. 1909*

The Still Road bridge is a four-span, 135'-long, 14'-wide, steel multi girder bridge supported on concrete-filled riveted steel caisson with I-beam cap bents. The bridge dates to ca. 1909 and was built by the Canton Bridge Company for the Kent County government as a replacement for an earlier timber bridge. The oldest surviving plans are from 1936, after the state highway department had taken over the bridge from Kent



The ca. 1909 Still Road bridge (State Bridge K-211A) was built by the Canton Bridge Company of Canton, Ohio. The bridge is among the state's oldest extant multiple-span steel multi girder highway bridges.



In 1936 the Delaware State Highway Department prepared plans to strengthen the Still Road bridge by adding four longitudinal steel I-beams to each span. Repairs also included replacing the timber deck and timber pile and sheeting abutment backwalls and wingwalls. These repair plans are the earliest known surviving plans for the ca. 1909 bridge.

County. In 1936, the department strengthened the bridge by adding four longitudinal steel I-beams to each span, changing it from the original six to ten lines of beams.

The bridge is among the state's oldest multiple-span multi girder highway bridges. It reflects the early 20th century application of the technology in a rural setting. Although the concrete-filled, riveted steel caisson bents were once very common,

these are the only extant examples identified in Delaware. The timber deck, and timber pile and sheeting abutment backwalls and wingwalls were rebuilt in 1936, and, according to state records, again ca. 1970. The railings were altered in the early 1990s by removal of the bottom pipe rails and attachment of W-beam guide railings in their place.

Kent County carried out an extensive

program of bridge construction during the years 1909-1914, building or rebuilding at least thirty-one bridges. The present Carters Bridge is the third span built to carry Still Road across the Choptank River. The two earlier bridges, one presumably constructed in 1867 and the other some time between 1867 and 1909, had both been timber structures. The Levy Court made a call for proposals for the construction of the third bridge around the early autumn of 1909. The county's specifications directed the removal of the present wooden bridge, and the construction of a replacement wooden structure with its floor one foot higher than that of its predecessor.

In its final form, the 1909 Carters Bridge diverged considerably from the county's initial intentions, being a steel multi girder structure supported by bents with caissons. The firm that constructed the new bridge, the Canton Bridge Company of Canton, Ohio, had been contracted by Kent County the preceding

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The 1920 Frederica Road bridge (State Bridge K-8F) is an example of the state highway department's standard encased steel multi girder bridge design.

April to erect a relatively long bridge across the inland margin of the tidal estuary of the Leipsic River at the village of Leipsic. The Levy Court awarded the contract for Carters Bridge to the company on November 9, 1909, for \$2,418, a sum well above the competing wooden-bridge bids of local contractors. Perhaps Kent County officials had been persuaded by arguments made by the Canton Bridge Company's engineer for the Leipsic bridge regarding the superiority of steel multi girder construction. The following year, 1910, the Kent County Engineer issued standard specifications for steel multi girder bridges.

The Canton Bridge Company, established in 1876, had its offices and shops in Canton, Ohio, a small city that had emerged around 1875 as a secondary center for the steel industry. The company was a relatively minor bridge building concern, generating 5,000 long tons of production in 1903, tying for eighth place among fourteen Ohio bridge companies for that year.



Frederica Road (Road 10) over Murderkill River

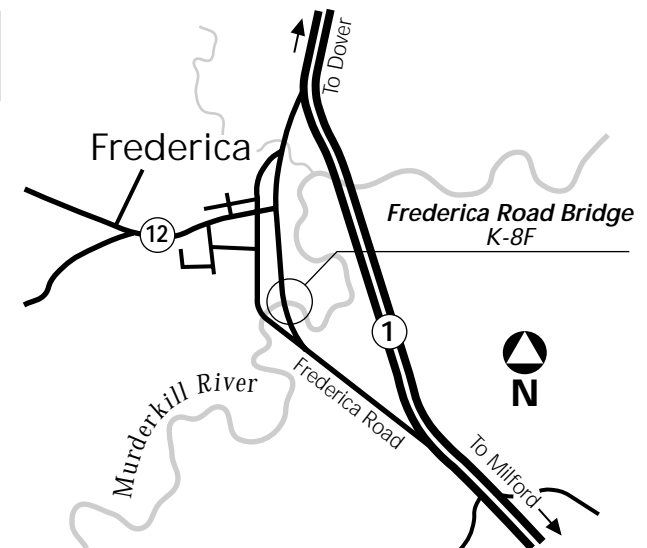
State Bridge K-8F

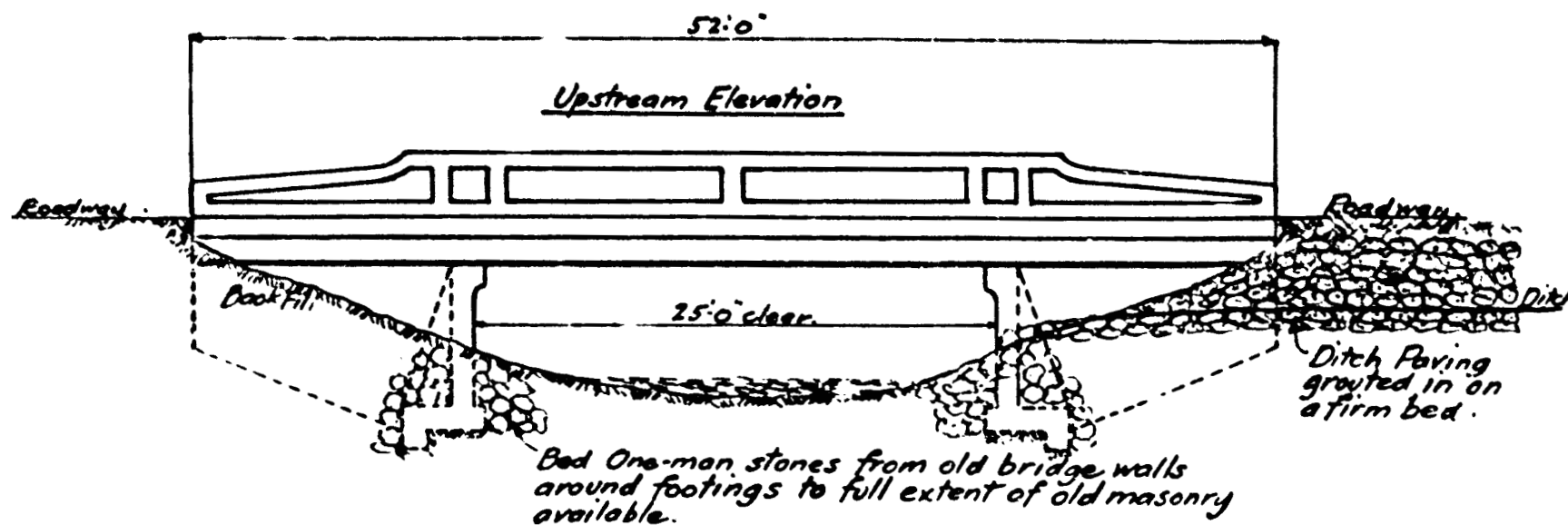
Frederica, Kent County

*Designer/Builder: State Highway
Department/S. S. Jones Contracting Corp.*

1920

The Frederica Road bridge is a four-span, 116'-long, 35'-wide, encased steel multi girder bridge finished with incised paneled concrete parapets and supported on concrete abutments and piers.





Elevation from 1922 drawings for State Bridge NC-182.

Constructed in 1920, the bridge is significant as an early, multiple-span example of a standard encased steel multi girder bridge designed by the state highway department. Established in 1917, the department did not begin the improvement of the state's roads and bridges in earnest until late 1919, after World War I and the passage of the State Aid Road Law, which authorized bonds to match federal financing. The standard-design encased steel multi girder bridge with paneled parapets lent itself to the state's campaign to improve the large number of bridges taken into the newly created state

highway system. Similar bridges were used throughout the state, although most extant examples are single span. The bridge type offered economy of design, ease of construction, and long-term maintenance cost benefits from the encased beams.

The bridge was built under Delaware State Highway Department contract 24A, one of the earliest contracts issued by the state. The contract was awarded to James A. Hiron of Dover for approximately \$84,500, and Hiron, in turn, sublet the contract to the S. S. Jones Contracting Corporation of New York City.

Faulkland Road (Road 270) over Hyde Run

State Bridge NC-182

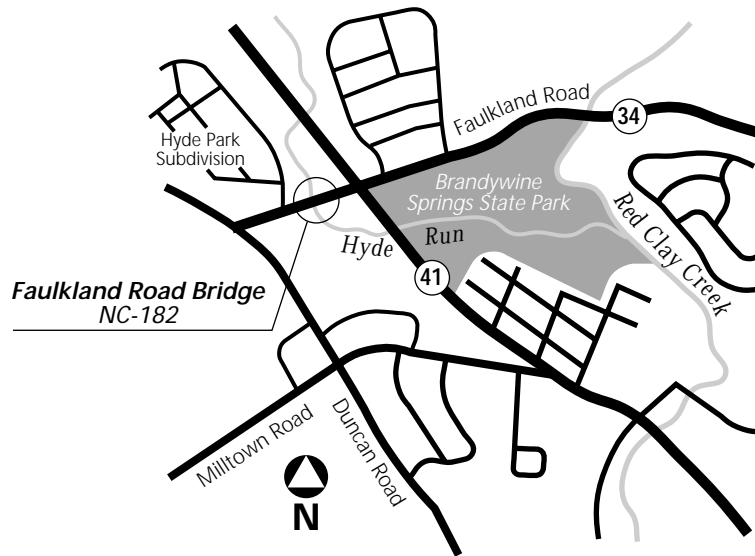
*Northwest of Prices Corner,
New Castle County*

*Designer/Builder: New Castle County
Engineer/Vincenzo Giovannozzi & Bros.*

1922

The Faulkland Road bridge is a 27'-long, 26'-wide, encased steel multi girder bridge built in 1922 for the New Castle County government. It is finished with incised paneled parapets that taper to a shal-

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lower depth at the end posts. The bridge is supported on concrete abutments with wingwalls. The seven lines of encased I beams at 4' spacings are supported on bridge seats that project outward from the abutments.

Contractor Vincenzo Giovannozzi & Brothers of Wilmington built the Faulkland Road bridge based on plans prepared by the county engineer. It is an early and complete example of a common county-built bridge type from the late 1910s to 1930s. It reflects the trend toward standardized 20th-century bridge types, such as the encased steel multi girder and the reinforced concrete

ABOVE: The Faulkland Road bridge (State Bridge NC-182) is an encased steel multi girder bridge that was built to plans prepared by the New Castle County Engineer in 1922.

LEFT: Many covered bridges, such as the one previously on Faulkland Road, were replaced as part of the road and bridge improvement campaigns of the first half of the 20th century. Encased steel multi girder bridges were a standard bridge type commonly used by Delaware's state and county governments for bridge replacement projects.





Wilmington

**North Market
Street Bridge
NC-575**

slab, as the county government pursued a systematic program of replacing obsolescent bridges, including covered bridges such as the one previously at this site. The replacement structures were designed to ac-

commodate increased and heavier motorized traffic. This bridge was designed for a 15-ton truck loading, a common live-load unit of the period.

North Market Street (Road 24) over Brandywine Creek

State Bridge NC-575

Wilmington, New Castle County

*Designer/Builder: Harrington, Howard &
Ash/Frederick Snare Corporation*

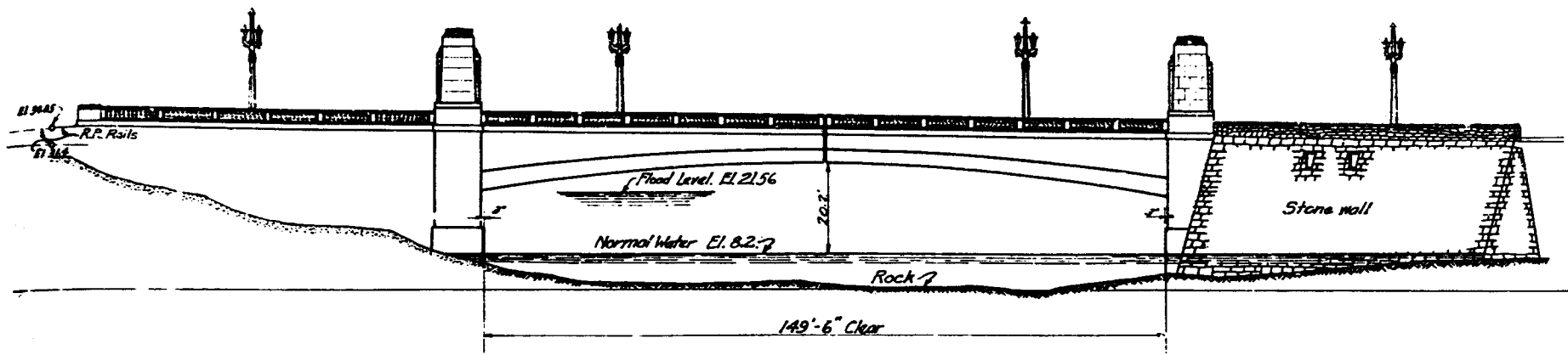
1928

The 1928 North Market Street bridge is an unusual, one-span, 213'-long, 83'-wide, steel cantilevered multi girder bridge composed of nine lines of haunched, built-up steel beams that are cantilevered from the abutments. The beams are connected at the abutments to concrete counterweights located in pockets extending 29' into the abutments. They anchor the dead and live



The 1928 North Market Street Bridge (State Bridge NC-575).

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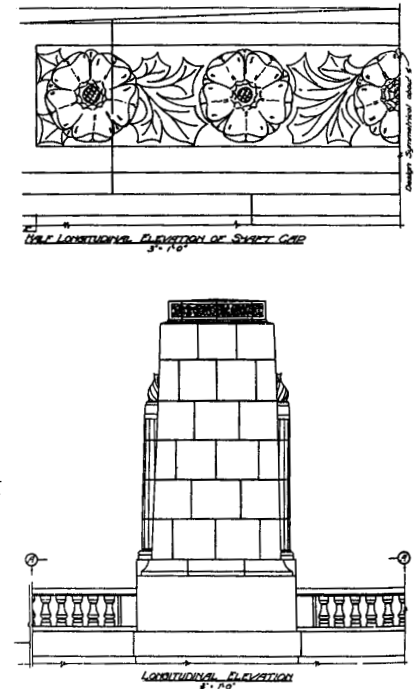
loads. Shear locks at mid span transfer shear forces across the beams. The fascia beams are concrete encased and scored to give the appearance of an arch. The bridge is finished by stone pylons and concrete balustrades with urn-shaped balusters.

The design of the bridge was mandated by constraints at the crossing such a high flood level and the existing grade of North Market Street. The bridge is historically noteworthy for the uncommon cantilever design, which allowed the builders to span a greater distance than would have been feasible with available rolled beams and also required a minimum of falsework. The only other example of a cantilevered steel multi girder bridge of similar age in the state is the 1931 Rockland bridge (State Bridge NC-2), also over Brandywine Creek.

The nationally recognized engineering firm of Harrington, Howard & Ash of Kansas City and New York City designed the bridge for New Castle County with the project under the direction of County Engineer Charles E. Grubb. The firm, established in the 1890s, was noteworthy for movable bridge designs before expanding to a variety of civil and structural engineering projects during the mid 20th century under the reorganized firm-name of Ash, Howard, Needles & Tammen. The firm was very active in Delaware and provided consulting services to the county and state highway department beginning in the early 1920s. General contractor for the North Market Street bridge was the Frederick Snare Corporation of Philadelphia and New York, for a bid of \$382,060.

ABOVE: Elevation drawing of the North Market Street Bridge, as prepared by Harrington, Howard & Ash, consulting engineers, in 1928.

RIGHT: Decorative details, such as the pylons with carved-stone cap, were befitting the North Market Street bridge's prominent downtown Wilmington location.



The present North Market Street bridge is believed to be the fifth bridge at this crossing. Authorized in 1762 by the Delaware General Assembly, the first Market Street bridge, a timber structure, was completed in 1764, replacing the previous ferry that had operated from a landing on French Street. The first bridge underwent numerous repairs, and in 1806, a company was formed to replace the deteriorated span with a stone arch bridge. That bridge was never built because local merchants and millers objected that the stone arch would restrict the waterway. The Levy Court continued to study various proposals for different bridges but took no action until 1809, when \$4,000 was appropriated to construct a chain suspension bridge, which would not restrict the stream. Completed in 1810, the suspension bridge remained in use until 1822, when a freshet washed it away. A timber covered bridge was next constructed, the first in Delaware; however, it too was destroyed by a flood in 1839. Master bridge builder Lewis Wernwag constructed the next bridge, a covered timber truss-arch that remained in place until 1887 when a

wrought-iron Pratt thru truss, fabricated by the New Jersey Steel and Iron Company, was erected in its place.

By the mid 1920s, the metal truss bridge was no longer adequate to the needs of increased automobile traffic. A traffic study conducted by the New Castle County Engineer revealed that 85 percent of the traffic on the bridge comprised passenger automobiles, and when combined with streetcar traffic was contributing to downtown traffic jams. Local businessmen looked forward to an improved crossing with greater capacity, which they believed would encourage economic growth. Specifications for the 1928 replacement bridge provided for a paved roadway of 60', accommodating double streetcar tracks, and two, 10'-wide sidewalks, more than doubling the capacity of the previous bridge. In order to maintain traffic during construction, the county required the contractor to complete the western side of the new bridge while traffic continued to use the previous metal truss bridge. When the western side was finished, the traffic was shifted to the completed portion while the old truss was re-

moved and then the east side of the new bridge was constructed in its place.

The Market Street bridge is located in the Brandywine Village Historic District, historically significant for its collection of 18th- and 19th-century homes, mills, and artisans shops, concentrated on the north bank of the creek.

Old Capitol Trail over Red Clay Creek (*Marshallton Bridge*)

State Bridge NC-155

Marshallton, New Castle County

*Designer/Builder: State Highway
Department Bridge Division/George
E. Shockley*

1931

The Marshallton bridge is a skewed, one-span, 119'-long, 24'-wide, built-up steel thru girder bridge. Finished with a segmental profile to the top, it is significant as an example of a common 20th-century bridge type with custom architectural detailing, documenting State Bridge Engineer Arthur G. Livingston's efforts to apply individual aesthetic treatments to many of the

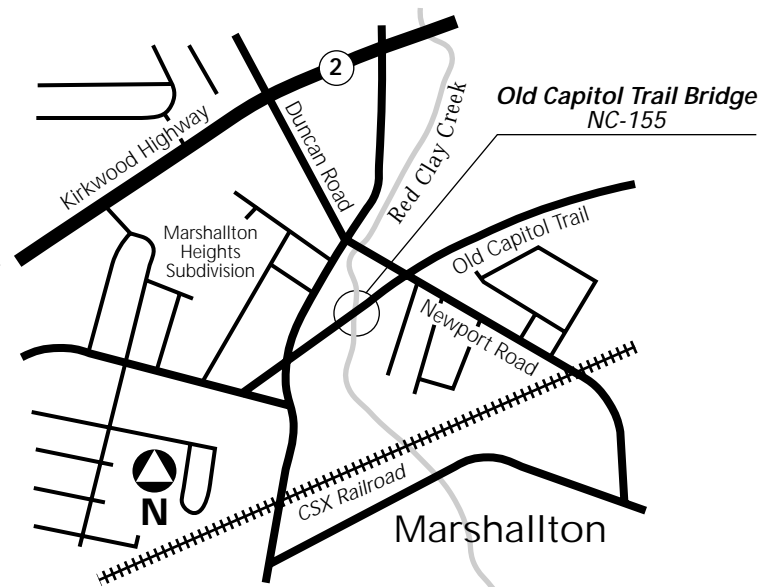
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bridges on the state's highway system. Built in 1931, the bridge has two cantilevered sidewalks finished with decorative metal railings with diamond-shape cutouts. Concrete block end posts are topped by obelisks with stepped pedestals and copper luminaires. The bridge is supported on concrete abutments with wingwalls.

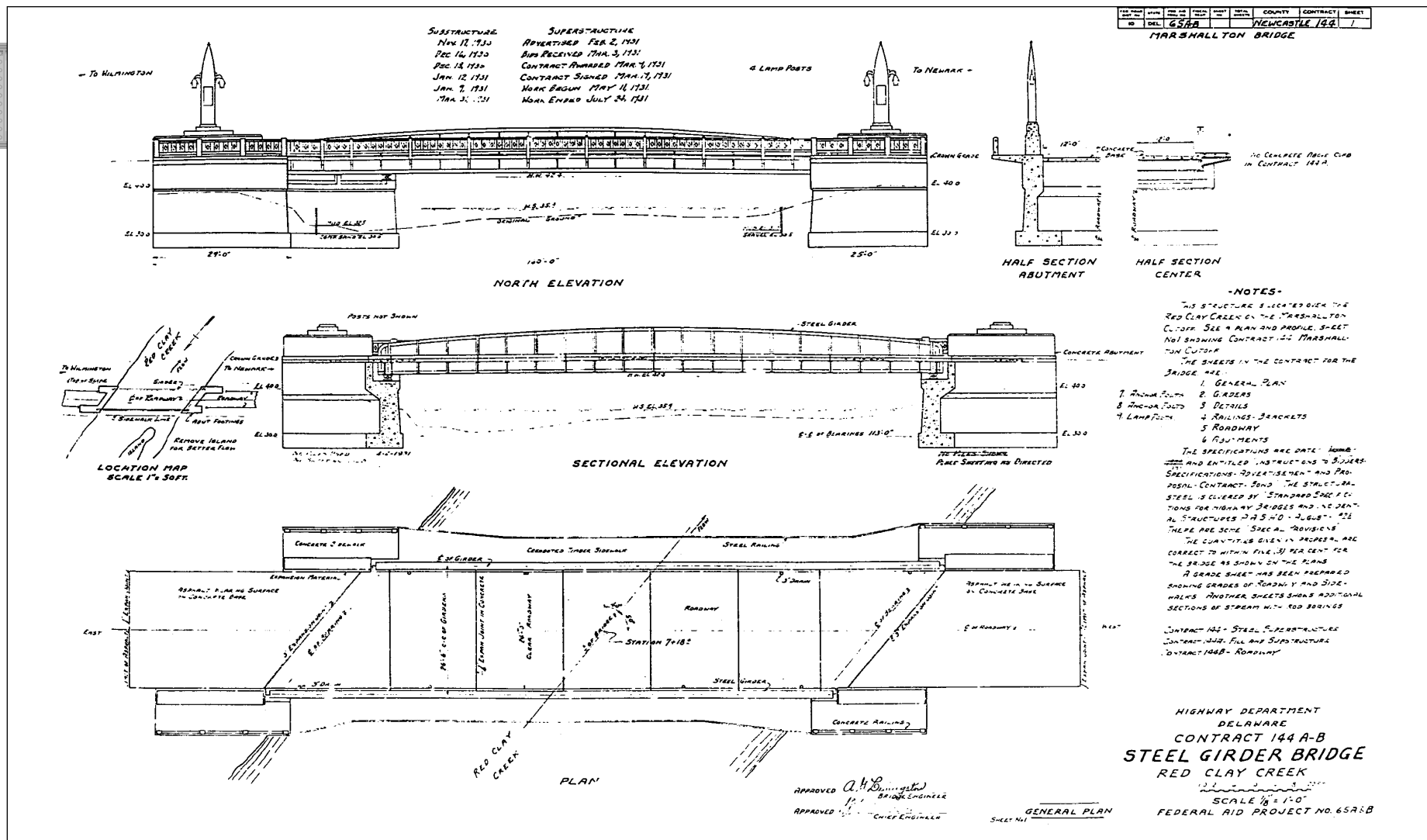
The Marshallton bridge was highlighted in the State Highway Department's *Annual Report* (1931), which stated that "through careful attention to details in its design this bridge presents an unusually pleasing appearance and with its approaches eliminates the traffic congestion and hazards which formerly existing on account of the narrow and winding route through town." The bridge was constructed as part of a 1930-31 road relocation project called the "Marshallton Cutoff." The cutoff bypassed the former state route, which was carried over Red Clay Creek on a 1919 Warren pony truss bridge (non-extant) located several hundred feet upstream of the present bridge. Road relocations were a common feature of the state highway department's efforts to improve the state highway system to meet

the demands of increasing automotive traffic from the 1920s to the 1950s, and this project, like many others, was assisted by federal-aid funds.

The department opened the cutoff and bridge at a formal celebration held on November 21, 1931. A newspaper item called the bridge "one of the finest structures of its kind in the county, the light standards adding much to its beauty." The concrete obelisks



The 1931 Marshallton bridge (State Bridge NC-155).



Elevation, section, and plan from the 1930 drawings for the Marshallton bridge prepared by the Delaware State Highway Department's Bridge Division.

marking the portals supported "Venetian" pendant lanterns on cast-bronze "Commonwealth" brackets, supplied by the Westinghouse Electric & Manufacturing Company.

DelDOT contract records indicate that the substructure was built by D. E. O'Connell & Sons of Ridley Park, Pennsylvania, and the superstructure was done by George E. Shockley of Rehoboth, Delaware. The total cost of the bridge was \$32,300. Shop drawings and bills of material document that the structural steel was furnished by the

Shoemaker Bridge Company of Pottstown, Pennsylvania, and the decorative steel railing by the Bauman Iron Works of Reading. In 1982, some rivets, mostly on the bottom flanges and floorbeam connections, were replaced by high-strength bolts. The original concrete slab deck has been replaced by a steel deck pan and concrete deck.

Metal Girder Bridges



Ease and speed of erection is a favorable construction feature of steel girder bridges. Photographs show the Marshallton bridge's prefabricated steel girders arriving via a nearby railroad (a), and then after being trucked to the bridge site, positioned by a crane (b). After connecting the floor-beams and placing the deck, workers apply the finishing touches, such as the pylons and luminaires (c). The completed bridge opened in July 1931, a mere five months after the contract had been awarded in March (d).

Road 46 over Deep Creek

State Bridge S-239

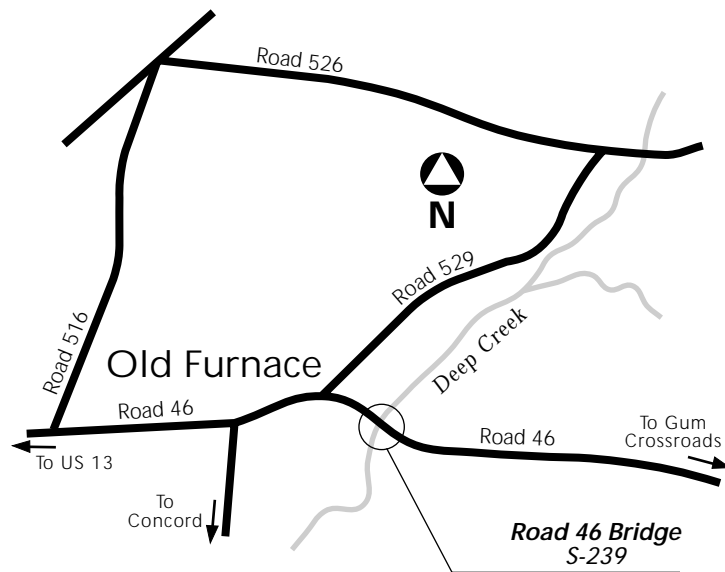
Old Furnace, Sussex County

*Designer/Builder: State Highway
Department Bridge Division/Continental
Contracting Corp.*

1932

The Road 46 bridge is a one-span, 40'-long, 31'-wide, encased steel multi girder bridge built in 1932. The bridge is finished by paneled concrete parapets with corbeled coping, and it is supported on concrete abutments with wingwalls topped by plain concrete parapets. The bridge is significant as a well-preserved example of the standard design, encased steel multi girder bridges built in numbers by the state highway department during the 1920s and 1930s.

The bridge was built as part of a state highway department project to pave and realign Road 46 between Gum Crossroads



The 1932 Road 46 bridge (State Bridge S-239) is a complete example of the standard encased steel multi girder bridge built in numbers by the state highway department during the 1920s and 1930s.



and Middleford, a distance of nearly four miles. General contractor for the project was the Continental Contracting Company of Baltimore. The bridge was located on a realigned portion of the road, replacing an earlier bridge, also a steel multi girder span.

An interesting sidelight to the story of this standard replacement bridge was that it was determined during construction of the foundations that the timber pilings needed to be increased in length in order to achieve adequate bearing, apparently a common problem encountered in the sandy soils of Sussex County. In contract correspondence, supervising engineer John R. Hitchins observed, "I do not believe we have ever constructed a bridge in Sussex County using the length of piles planned. In every case we found them too short." Longer piles were more costly, but did not represent unusual technical problems.

Metal Girder Bridges

Rockland Road (Road 235) over Wilson Run

State Bridge NC-68

Rockland, New Castle County

Designer/Builder: New Castle County

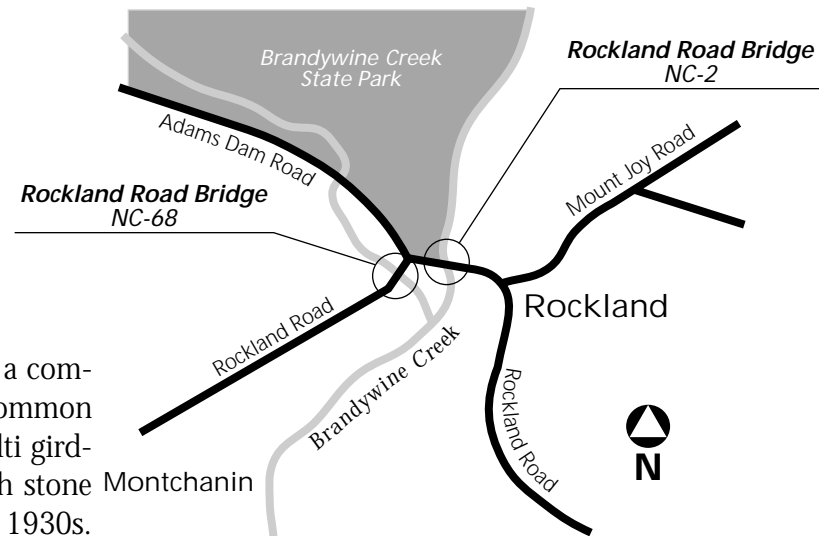
Engineer/Charles H. Dunleavy

1932

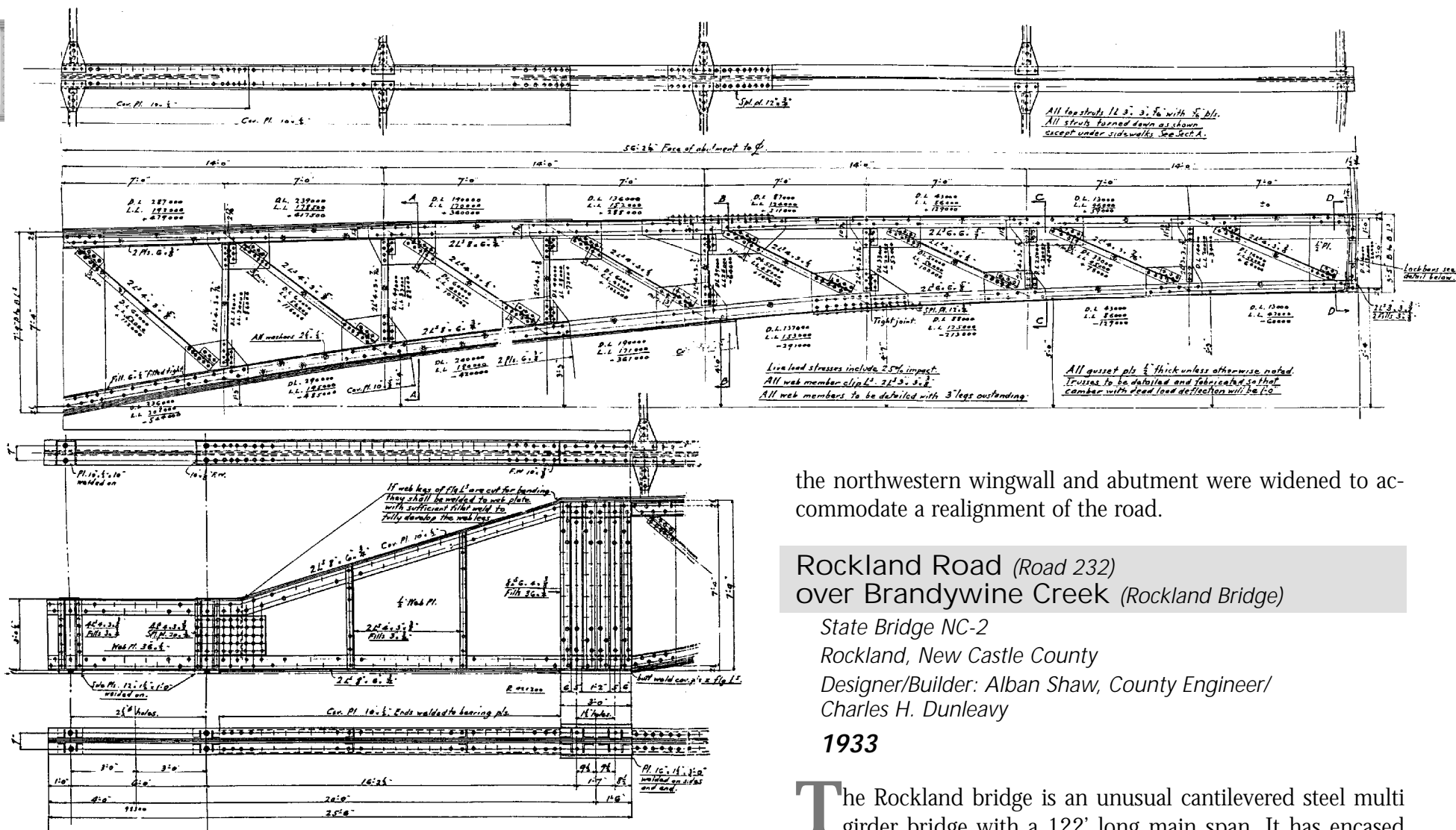
The Rockland Road over Wilson Run bridge is a one-span, 23'-long, 34'-wide, encased steel multi girder bridge built in 1932. It is finished by stone parapets and is supported on rubble masonry abutments with wingwalls. A small, two-story, stone building, which is believed to have been associated with a former grist mill, is built into the bridge's southwest wingwall. The original function of the building is unclear, although it may have served as a springhouse or mill-race gatehouse. The bridge's northeast wingwall is contiguous with the stone wingwall of State Bridge NC-2, built in 1933.

The bridge is significant as a complete example of the once common county-built encased steel multi girder bridge type and design with stone parapets from the 1910s to the 1930s. It is also a contributing resource in the National Register-listed Rockland Historic District. Rockland is a former mill village surrounding a 19th-century paper mill complex on the east bank of Brandywine Creek, and the site of a former grist mill on the west bank of the creek, adjacent to the bridge.

Contractor Charles H. Dunleavy of Coatesville, Pennsylvania, built the bridge based on plans prepared by the New Castle County Engineer. The project included removal of a pony truss bridge and replacement with the steel multi girder superstructure. The previous abutments were reused, although



The 1932 Rockland Road over Wilson Run bridge (State Bridge NC-68) is a complete example of the common county-built encased steel multi girder bridge design with stone parapets.



Plans for the 1932 Rockland bridge show the built-up, open web girders. The tapered portion of the girder (bottom left) is framed into the concrete counterweights that are set in pockets in the abutments.

the northwestern wingwall and abutment were widened to accommodate a realignment of the road.

Rockland Road (Road 232) over Brandywine Creek (Rockland Bridge)

State Bridge NC-2

Rockland, New Castle County

Designer/Builder: Alban Shaw, County Engineer/
Charles H. Dunleavy

1933

The Rockland bridge is an unusual cantilevered steel multi girder bridge with a 122' long main span. It has encased haunched built-up open-web girders framed into the counterweights that are set in pockets in the abutments. The counterweights anchor the dead and live loads. Shear locks at mid span transfer shear forces across the beams. The seven lines of cantilevered beams have concrete diaphragms. A 10'-long, reinforced concrete rigid frame span over a former mill race is at the west end of the bridge. Built in 1933 for New Castle County

Metal Girder Bridges

government under the direction of county engineer Alban P. Shaw and general contractor Charles H. Dunleavy of Coatesville, Pennsylvania, the bridge is handsomely detailed with the fascia scored to appear like stone voussoirs. The uncommon cantilever design allowed for ease of construction with a minimum of false-work. It is similar to the earlier 1928 North Market Street Bridge over Brandywine Creek (State Bridge NC-575) in Wilmington, also a cantilevered multi girder bridge.

In 1993, deteriorated concrete encasement, deck, sidewalks, and parapets were removed by DelDOT and replaced using a lightweight concrete. Original architectural details, such as battered pylons and balustrades were carefully reproduced. Although new from the deck up, the bridge's unusual cantilevered steel multi girder superstructure remains intact, and the rehabilitation was done in a sensitive manner that does not detract from the original design.

The bridge is located in the Rockland Historic District, a 19th-century mill village with former paper mill, converted to condominiums.



ABOVE: The 1932 Rockland Road over Brandywine Creek bridge (State Bridge NC-2) is an unusual cantilevered steel multi girder design with Moderne-style details. The railings and pylons were reproduced carefully following a 1993 rehabilitation project by DelDOT.



LEFT: The underneath view of the Rockland Road bridge shows the haunched, encased steel girders.



The mill race and dam are upstream of the bridge. The steel multi girder bridge from 1933 replaced a wooden covered truss bridge that had carried Rockland Road since 1833.

Washington Street over Mispillion River

State Bridge K-501

Milford, Kent County

Designer/Builder: Unknown

1933



The 1933 Washington Street bridge in Milford (State Bridge K-501).

The 1933 Washington Street bridge is a skewed, one-span, 44'-long, 41'-wide steel multi girder bridge. It has concrete diaphragms. It is finished with incised paneled concrete parapets and supported on concrete abutments. Two concrete light standards remain on the east side of the bridge but have been lost from the west side. State records indicate the bridge was built by Milford City in 1933. The designer

Metal Girder Bridges

and contractor are not listed in state records. The bridge is a well preserved example of the standard steel multi girder bridge type built by state, county and municipal governments throughout Delaware and the United States, from the 1910s through the 1930s.

Silver Lake Road (Road 442) over Silver Lake Spillway

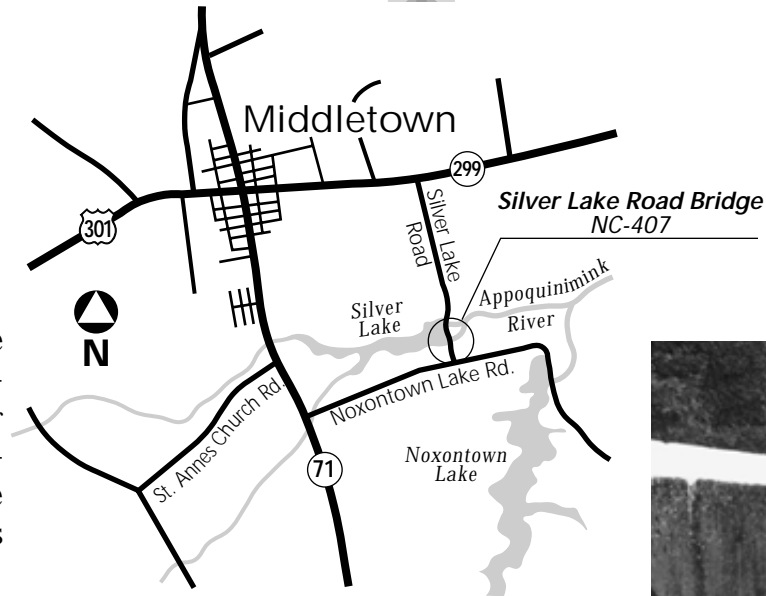
State Bridge NC-407

*Southeast of Middletown,
New Castle County*

Designer/Builder: Unknown

1935

The Silver Lake Road bridge is a one-span, 22'-long, 22'-wide, encased steel multi girder bridge. It is supported on concrete abutments with wingwalls directing the flow of water on the downstream side of the Silver Lake dam spillway. The spillway floor is an invert concrete slab. The



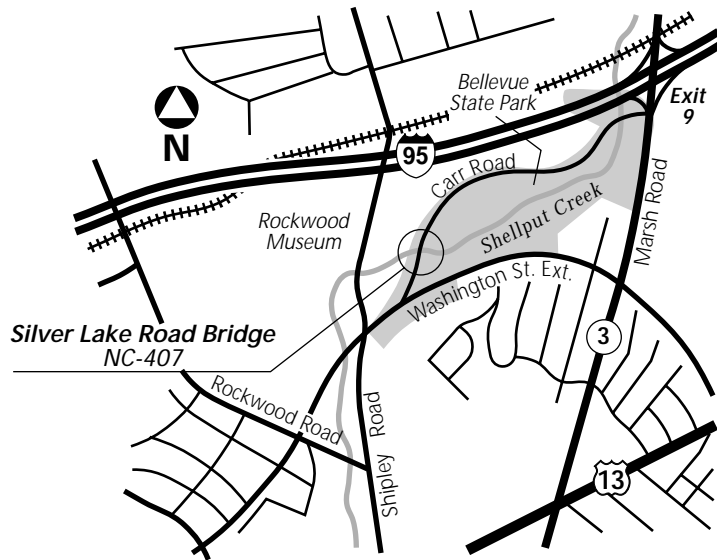
bridge is finished with concrete parapets with diamond-shape panels and endpost pylons on the west elevation only. The pylons support concrete flower planters. A steel gate frame with wood sluice gates is built into the bridge's upstream side for controlling water flow from Silver Lake. The lake is a former mill pond, associated with a grist mill located at the northeast corner of the earthen dam. The mill has been converted to apartments.

The bridge is a representative example of the steel multi girder bridge type that was prevalent in Delaware during the first half of the 20th century. It was chosen for

The 1935 Silver Lake Road bridge (State Bridge NC-407) spans the Silver Lake Spillway. Sluice gates are built into the bridge's upstream side.



its historical and technological significance from the population of similar multi girder bridges because of its historic association with the dam/spillway, custom-design parapets, and integrity of original design. Records state that the superstructure of the bridge was placed in 1935 after a flood had partially destroyed the previous bridge.



The bridge was rebuilt reusing the surviving abutments, which were placed in 1931. An inscription in the north abutment confirms the 1931 date. The bridge was built by the county, but no engineer or contractor are cited in any available records.

Carr Road (Road 213) over Shellpot Creek

State Bridge NC-543

Bellevue State Park, New Castle County

*Designer/Builder: Delaware State
Highway Department/Union Paving
Company*

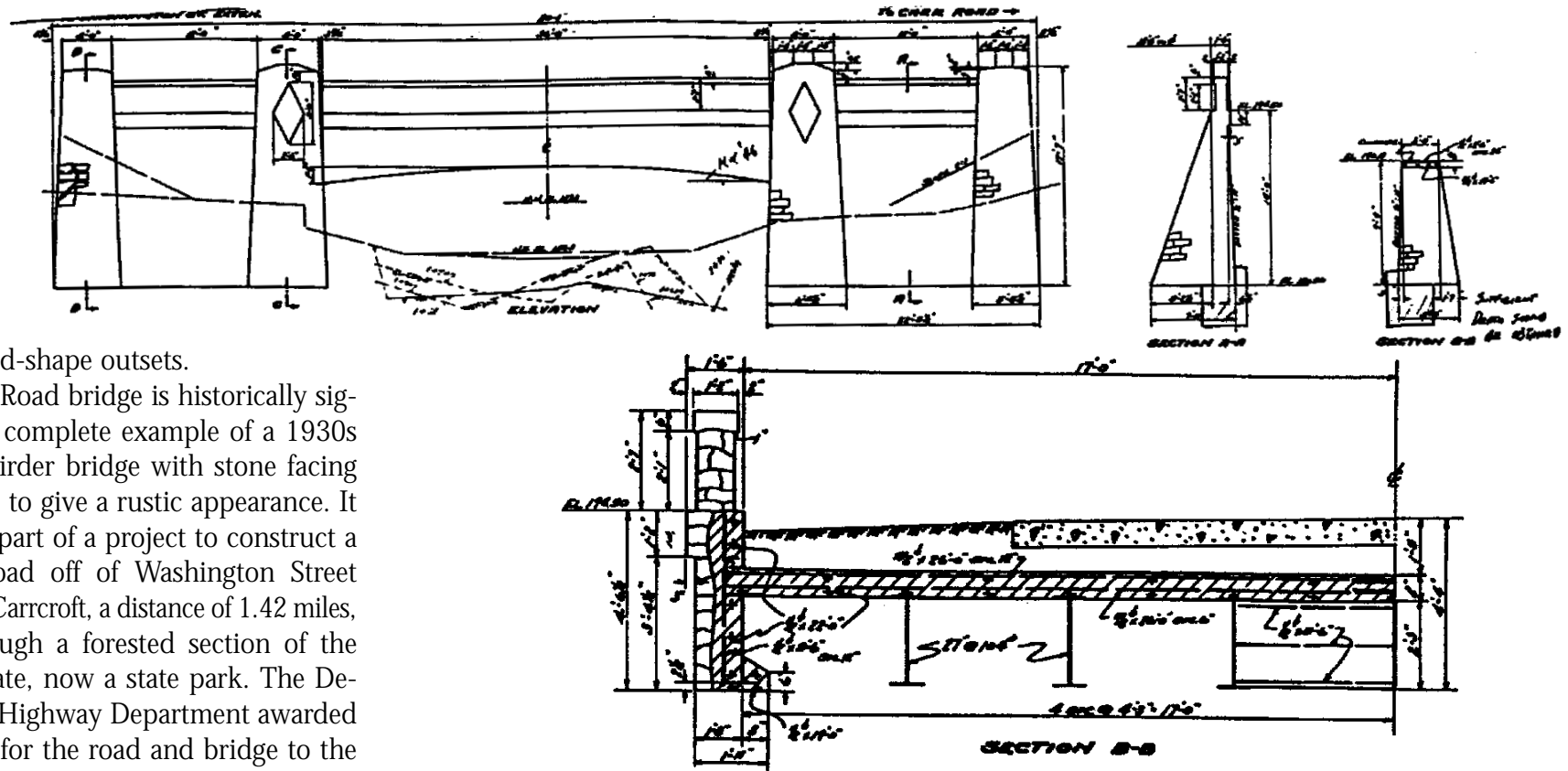
1936



The 1936 Carr Road bridge (State Bridge NC-543) has stone facing and parapets to present a rustic appearance.

The Carr Road bridge, built in 1936 by the state highway department, is a one-span, 40'-long, 37'-wide, steel multi girder bridge consisting of nine lines of rolled I-beams. The fascia beams are haunched and have a stone veneer to present the appearance of an arch bridge. The bridge is supported on stone abutments with U-shaped wingwalls and is finished with stone parapets and a corbeled stone belt course extending across the fascia at roadway level. Stone pilasters are located at each of the abutment corners. The pilasters form the parapet end posts, which are decorated

Metal Girder Bridges



with diamond-shape outsets.

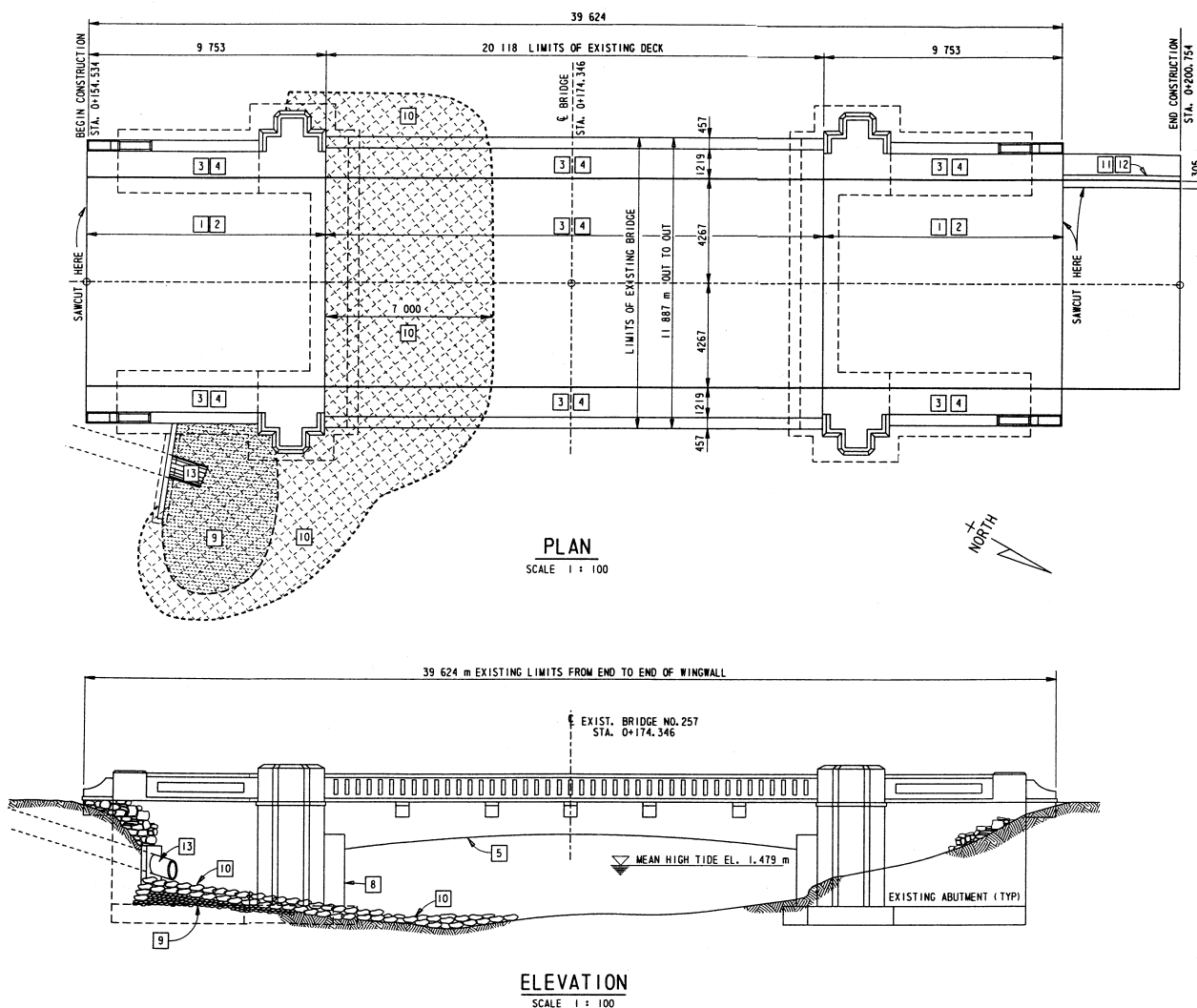
The Carr Road bridge is historically significant as a complete example of a 1930s steel multi girder bridge with stone facing and parapets to give a rustic appearance. It was built as part of a project to construct a new spur road off of Washington Street Extension to Carrcroft, a distance of 1.42 miles, passing through a forested section of the Bellevue Estate, now a state park. The Delaware State Highway Department awarded the contract for the road and bridge to the Union Paving Company of Philadelphia for over \$50,000.

Contract drawings and notes provide insight into the desire to construct the bridge with a stone facing and parapets. State Bridge Engineer Arthur G. Livingston commented that “the site shows exposed rock thickly located around the entire vicinity; con-

Elevation and section drawings for the Carr Road bridge. The drawings were prepared by the state highway department’s bridge division in 1933.

struction should conform as closely as possible to the surrounding country.” He also indicated his design was influenced by other nearby stone-faced structures: “[The bridge] will be similar to the structure already built

across the same stream about a half a mile [away]. This will make on the Shellpot Creek three rubble masonry structures and an I-beam span on the Industrial Highway.” Livingston, like many bridge engineers, was



Plans for repairs to the State Route 7 bridge in 1996. DelDOT redecked the bridge, repointed the masonry, and strengthened the rolled I-beam girders with stiffener plates and diaphragms. The repairs maintained the bridge's historic appearance.

influenced by the ideas of landscape architects who promoted the idea that a structure's surrounding should influence its form. Stone masonry was an appropriate response to the landscape of upper New Castle County, where there are many rock outcroppings and buildings, walls, and fences built of native granite.

State Route 7 over Christina River

State Bridge NC-257

Christiana, New Castle County

Designer/Builder: Delaware State Highway Department

1937

The State Route 7 bridge is a one-span, 66'-long, 39'-wide, steel multi girder bridge built in 1937 by the Delaware State Highway Department. The fascia girders have been faced with stone to appear as shallow stone arches complete with voussoirs and keystones. The bridge is finished with stone balustrades and parapets over the wing-

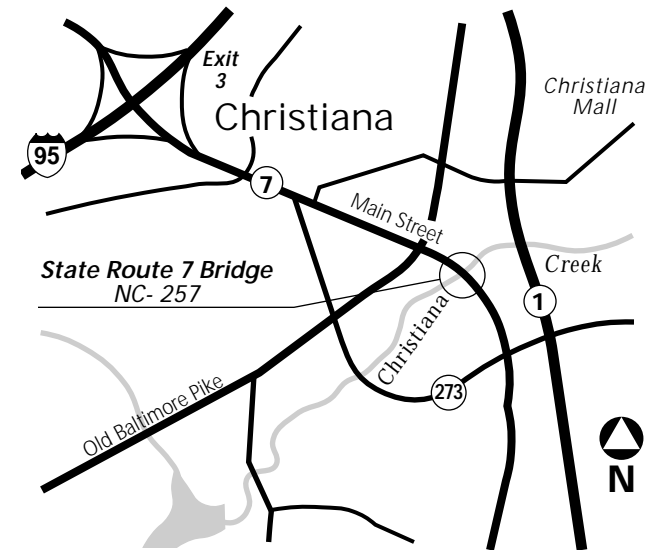
Metal Girder Bridges

walls. It is supported on rubble masonry abutments. The bridge is historically significant as one of the longest and best preserved of several 1930s stone-veneered steel multi girder bridges in New Castle County. State Bridge Engineer Arthur G. Livingston designed the bridge with local stone to blend with the natural environment and imitate traditional stone arch construction.

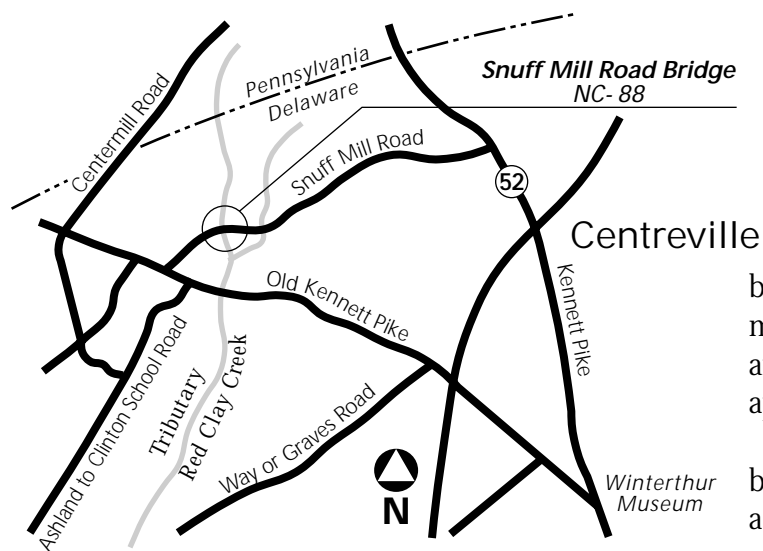
Original drawings on file at DelDOT indicate that the State Route 7 bridge replaced a pony truss swing span bridge at the same location. The center-bearing swing span was supported on rubble masonry pier and abutments with wingwalls, and specifications for the replacement structure allowed for the reuse of the stone, providing it was cleaned and free of all mortar. By the 1930s, the upper reaches of the Christina River were no longer important to navigation, and permission was received from the U. S. Army Corps of Engineers to replace the movable bridge with a fixed span.

The bridge underwent repairs in 1996.

It was redecked using a lightweight concrete, the stone balustrades were repointed, and the rolled I-beam girders strengthened with stiffener plates welded to the webs. The sidewalks were divided from the roadway by the addition of metal pedestrian



The 1937 State Route 7 over Christina River bridge (State Bridge NC-257) is one of the longest of several 1930s stone-veneered steel multi girder bridges in New Castle County.



barriers. The repairs were performed in a manner sensitive to the original materials and that maintained the bridge's original appearance from both elevations.

The bridge straddles the southeastern boundary of the Christiana Historic District, a commercial village that thrived prior to

1850 because of its location at the Christina River's navigable headwaters.

Snuff Mill Road (Road 244) over Red Clay Creek Tributary

State Bridge NC-88

West of Centreville, New Castle County

Designer/Builder: Delaware State

Highway Department/Olivere Paving & Construction Company

1939



The 1939 Snuff Mill Road bridge (State Bridge NC-88).

The Snuff Mill Road bridge is a one-span, 37'-long, 27'-wide, encased steel multi girder bridge supported on concrete abutments. The bridge has stone faced veneer and stone parapets. Built in 1939, the bridge is a complete and well-proportioned example from among several similar stone-faced multi girder bridges built in New Castle County during the 1930s. This bridge was designed by the Delaware State Highway Department's bridge department and built by contractor Olivere Paving &

Metal Girder Bridges

Construction Company of Wilmington. The department instructed the contractor to match the stone for the bridge with stone used by Mr. Haskell, owner of an adjacent estate property. The bridge is another example of the department's efforts to match its bridges with the existing landscape. Nationally, stone veneers were applied frequently to steel girder and other bridge types like reinforced concrete arches and slabs beginning in the early 20th century. In northern New Castle County, the practice reached its height during the 1930s.

State Route 82 (Mt. Cuba Road) over Red Clay Creek

State Bridge NC-119

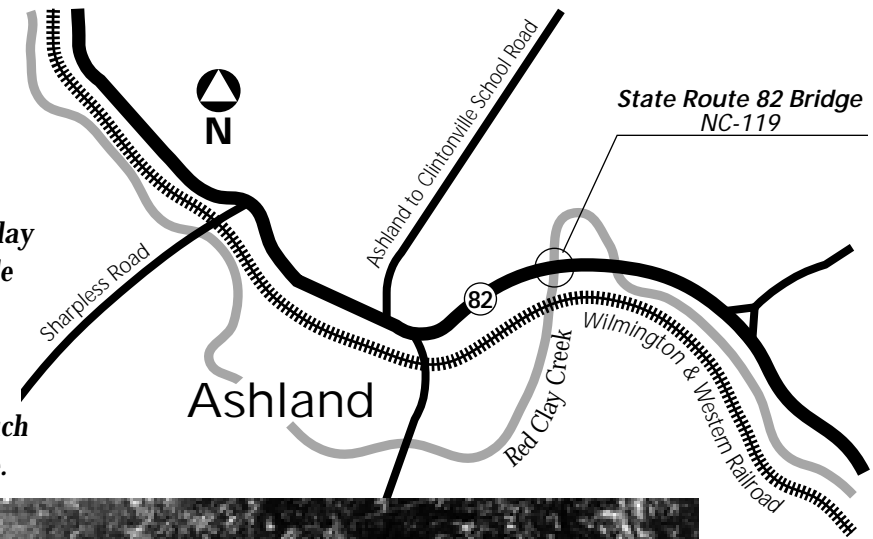
Ashland, New Castle County

Designer/Builder: Delaware State Highway Department/Oliver Paving & Construction Company

1939

Built in 1939 by the state highway department, the State Route 82 bridge is

The 1939 State Route 82 bridge (State Bridge NC-119) over Red Clay Creek has distinctive Moderne-style stepped pylons at the corners. It illustrates the adoption of then-current architectural styles to embellish common bridge types, such as the steel thru girder bridge type.





The photo shows the bridge as it appeared when completed in August 1939. The adjacent truss railroad bridge, which carries a single track of the Wilmington & Western Railroad, still exists.

a one-span, 110'-long, 27'-wide, steel thru girder bridge with distinctive Moderne-style stepped pylons at the corners. The concrete wingwalls are finished with concrete parapets with stepped end posts. The superstructure consists of two, 7'-deep, built-up girders with I-beam floorbeams carrying a concrete slab deck. The bridge is supported on concrete abutments.

The thru girder bridge is an example of a common 20th-century bridge type with fine custom details, illustrating the adoption of Moderne-style parapets by the state highway department in the late 1930s. Moderne style railings continued to be used by the department through the 1950s. Thru girder bridges were most often built as utilitarian structures devoid of embellishment, and this bridge illustrates the extra efforts that Delaware's state highway department often took with custom details.

The previous bridge at this crossing was a covered bridge that was destroyed by a

Metal Girder Bridges

flood on July 13, 1938. The state highway department bridge department designed the replacement bridge and awarded the contract to Olivere Paving & Construction Company of Wilmington for approximately \$28,500 in December 1938. A portion of the replacement cost was funded by the federal New Deal program administered by the Public Works Administration.

State Route 20 Eastbound (*Stein Highway/ Tull Crossing*) over Conrail (Delaware Railroad) and Cedar Street

State Bridge S-257E

Seaford, Sussex County

Designer/Builder: Delaware State Highway Department/M. J. McDermott

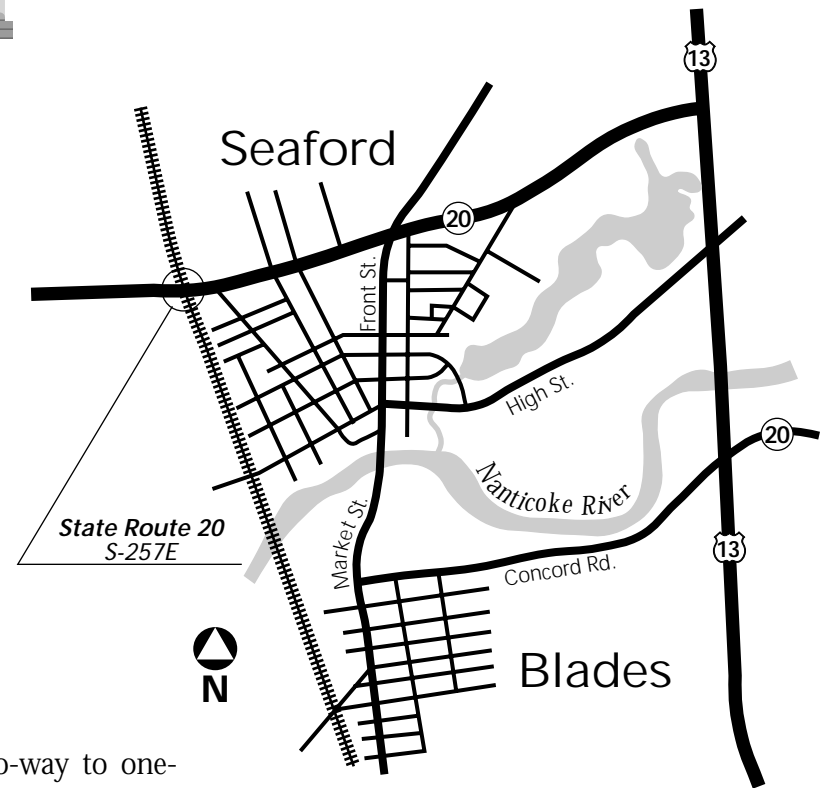
1940-41

The 21-span, 567'-long bridge consists of a 40'-long encased steel multi girder main span over the railroad, and continuous, variable-depth, reinforced concrete slab ap-

proach spans. The bridge is finished with handsome concrete parapets with bush hammer-finish panels and red diamond-shaped tiles. It is supported on arched concrete bents with brackets. The bridge has no history of significant alterations or modifications, although it has been converted from two-way to one-way traffic.

Built in 1940-41 for the state highway department, the State Route 20 bridge is historically significant as a complete example of a New Deal-era grade crossing elimination bridge with Moderne-style details. The bridge, also known as "Tull Crossing," was designed to eliminate a grade crossing with the Delaware Railroad, a division of the Pennsylvania Railroad, on the northeast end of Seaford. In the early 20th century,

grade crossings posed an increasingly dangerous junction between railroad and highway traffic, accounting for thousands of fatalities in the United States. Railroads took measures to eliminate dangerous crossings, especially in congested urban areas where automobile traffic also caused delays to the railroad's own traffic, but it was not until after 1919 and the era of federal and state funding for highways and bridges that





The 1940-41 State Route 20 bridge (State Bridge S-257E) is historically significant as a complete example of a New Deal-program grade-crossing elimination bridge with Moderne-style details.

wholesale grade crossing elimination programs were undertaken outside of larger cities. The Delaware State Highway Department announced a systematic program to eliminate hazardous crossings in 1926, and this effort was supplemented after 1935 by a New Deal program that offered federal funding for such overpasses. In 1940-41, the State Route 20 bridge was built with federal funding from the Federal Aid Grade Separation program matched by funds from the Delaware State Highway Department

and the Pennsylvania Railroad.

The state highway department's bridge department designed the State Route 20 bridge with the final plans forwarded to the Pennsylvania Railroad's engineering department for approval. The contractor for the bridge was M. J. McDermott of Georgetown, Delaware, for a price of over \$74,000. As first contemplated, the bridge was to have approach embankments on fill, but this was abandoned as aesthetically unsuitable for an in-town location where an open-type

structure of approach spans on concrete bents was preferred. It provided better access to properties adjacent to the structure.

The approach spans are an early use of continuous, variable-depth, reinforced concrete slab technology. The continuous design is an economical use of material, allowing longer spans for the given depth of slab than would have been possible with simple, non-continuous spans. Continuous designs, both in reinforced concrete and steel, came to the fore nationally in the 1930s,

Metal Girder Bridges

and were ubiquitous by the late 1940s and early 1950s.

State Route 141 (Tyler McConnell Bridge) Over Brandywine Creek And Road 260 (Brecks Lane)

State Bridge NC-587

East of Greenville, New Castle County

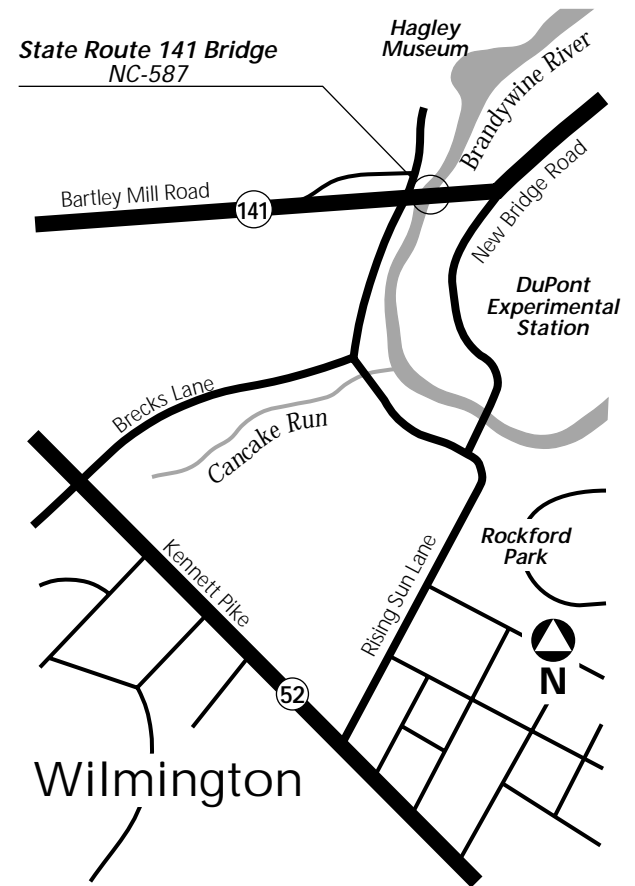
Designer/Builder: Parsons, Brinckerhoff, Hall & MacDonald/James Julian Inc.

1951-52

The 12-span, 816'-long Tyler McConnell Bridge consists of three-span continuous, haunched, built-up, deck girder main spans with span lengths of 87'-156'-87', flanked by six, 53'-long steel multi girder spans to the west, and three to the east. The main spans have rolled steel floorbeams, stringers, and crossbracing. The concrete deck is finished with concrete safety shape parapets with metal hand railings, placed in

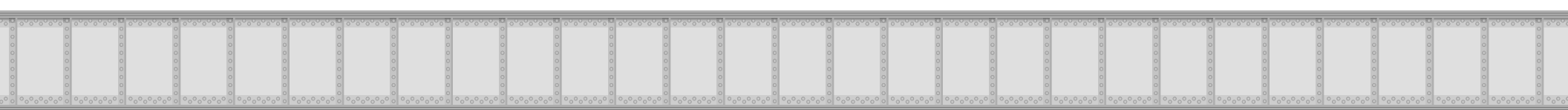
1980-82. The 33'-wide bridge is supported on reinforced concrete abutments and high reinforced concrete hammer head piers consisting of hammer-shaped pier caps integral with single column stems. The piers are accented by checkerboard-pattern scoring.

The Tyler McConnell Bridge, built in 1951-52, is a technologically significant deck girder bridge reflecting important mid-20th-century refinements of the steel girder bridge type. The bridge is Delaware's largest pre-1957 continuous steel girder bridge, and one of the earliest documented examples of the use of hammer head piers in the nation. Long-span continuous steel girder bridges were increasingly popular after 1945 because of the economy of material achieved in comparison to simply supported spans. Continuous designs allowed for longer spans for the given depth of beam. The 156'-long haunched girders reflect this economy of material, achieving their great-



est depth over the piers of the main span where the stresses are greatest.

Hammer head piers were an important refinement of substructure design. They were first used beginning in the early 1950s and became increasingly popular because of the



economy of material, lessening the weight on the foundation and cost of construction. The style of pier was made possible in part because of the increased availability of higher strength concrete. The hammer head design had the additional advantage of less foundation work in the ground. The design was frequently used for the interstate highway programs of the 1960s and 1970s, and it continues to be built. Thus, the 1951-52, Tyler McConnell Bridge documents the introduction of an important new substructure design.

Planning for the bridge began in 1948, when the E. I. DuPont de Nemours Company (DuPont) approached the state highway department with its plans to expand its experimental station on the east bank of the Brandywine Creek in North Wilmington. The company desired better access to the facility, and it offered to donate \$250,000 toward the construction of a new bridge (about half the original cost), as well as provide preliminary survey work.

In cooperation with DuPont, the state

highway department hired Parsons, Brinckerhoff, Hall & MacDonald, consulting engineers of New York City, to design the bridge. Assigned to the project was the firm's chief bridge engineer, Alfred Hedefine (1906-1981), one of the nation's leading bridge designers of the mid-20th century. He was largely responsible for such important structures as the 1939 World's Fair Trylon and Perisphere; the Talmadge Bridge, Savannah, Georgia (1950-51); the Arthur Kill Bridge, Staten Island, New York (1959); the Newport Suspension Bridge, Newport, Rhode Island (1965-69); and, the Fremont Bridge, Portland, Oregon (1973).

The first task facing Hedefine was consideration of a steel arch bridge versus a steel deck girder bridge for the Brandywine Creek crossing. Although all agreed that the former was more aesthetic, calculations proved the latter design far more economical, and the deck girder bridge was selected based on cost. It was Hedefine who met with Delaware state officials at the bridge site in

April 1950, presenting a sketch of a new type of pier with a hammer-head shape and recommending its substitution for more conventional bents or solid-stem piers. Construction began in February, and the piers, perhaps the most innovative part of the project, were a detail of frequent discussion between the engineers and the contractor, James Julian of Wilmington. Having no experience with the construction of hammer head piers, careful consideration was given to the formwork, with several revisions made before Hedefine was satisfied that it was strong enough to support the cantilevered portion of the pier heads. Although the substructure was complete by late 1951, a steel strike delayed delivery of the superstructure from the Phoenix Bridge Company, Phoenixville, Pennsylvania, until June 1952. The bridge opened to traffic in December 1952, and was dedicated the J. H. Tyler McConnell Bridge in April 1953. McConnell was a member of the Delaware State Highway Commission. ■

Metal Girder Bridges



ABOVE: Tyler McConnell Bridge (State Bridge NC-587) over the Brandywine Creek as seen from downstream. Opened in December 1952, the bridge provided a new crossing of the stream near the DuPont Company's experimental station.



RIGHT: The Tyler McConnell Bridge was constructed during 1951-1952. It is Delaware's largest pre-1957 continuous deck girder bridge.



The reinforced concrete hammer head piers were an innovative design, lessening the weight on the foundation and reducing the cost of construction. The Tyler McConnell Bridge is one of the nation's earliest documented uses of hammer head piers. They remain one of the most popular pier types in use today.